



Snow Pit Procedures



Background: A snow pit is a trench exposing a flat, vertical snow face from the snow surface to the ground. It allows you to study the characteristics of the different layers of the snowpack that have developed as the snow has changed due to compaction and weather changes. Snow pits are routinely used in mountainous areas to determine if one layer might slip on another causing an avalanche. Snow pits also help researchers measure the water content of a snow pack. This is essential in flood prone areas, and it is essential in those dry areas where the snowpack provides all of the water for the coming year.

As snow accumulates and changes over time, it develops layers of snow marked by their physical differences and reflecting the life history of the snow pack. These layers are often broadly classified as new snow, firn and depth hoar (careful observers often distinguish other layers within these categories). In general the new snow layer consists of new sharp crystals lying loosely on the top of the snow bank that are slowly being compacted by additional falling snow. Just below the new snow is a layer called firn. The firn consists of crystals that have lost their sharp edges due to evaporation, freezing and compaction. They are now rounded into more sphere-like shapes, in the process of becoming particles of ice. This snow is dense and the grains are more closely bonded together which increases the mechanical strength of the firn layer. At the bottom of the snowpack is the depth hoar layer consisting of snow crystals that have transformed (metamorphosed) into lumps of ice through evaporation, condensation, and compaction. This layer is more weakly bonded than either the firn or new snow layers. The depth hoar layer is loose and grainy. The crystals sift through your fingers and it is often nicknamed sugar snow.

Purpose: To study the layers of the snowpack and to compare the layers with past weather events. You should examine the data to see if there is any relationship between basic weather data (such as, air temperature, humidity, pressure, wind speed and direction, and cloud types) and the layers in the snowpack. Comparing your snow pit data with data from other parts of the country should help you to understand how differences in climate affect snowpacks.

Overview: The study of your snow pit will be separated into several steps. Each step will have its own procedure. Basic weather data will be recorded on a Weather Watch Field Data sheet. All snow pit data will be recorded on a Snow Pit Field Data sheet.

The steps are:

1. Locate and Prepare Snow Pit
2. Make Basic Weather Measurements
3. Map Study Site
4. Obtain Basic Site Data
5. Measure Temperature Profile of Snowpack
6. Mark Snow Layers
7. Determine Snow Grain Size and Shape
8. Measure Snow Density and Snow Water Equivalent.

Materials:

- Snow Shovels
- Metric Tape Measure (30m)
- Compass
- Clinometer
- Thermometers (3) – preferable a dial stem variety to insert into snow face
- Soft paintbrush – 4 inch
- Golf tees, popsicle sticks, etc. to mark transition horizons between layers
- Pencil with eraser and knife
- Spatula
- Hand lens (5X or 10X)
- Snow crystal card or playing card to hold snow grains (Life-Link Snow Pit or Snow Crystal Card recommended)
- Small plastic centimeter/millimeter ruler
- Mass scale – inexpensive, but accurate, gram/kilogram kitchen scale. (It should have the capacity to mass the snow in the sampling tube.)
- Snow sampling tube (This is a small, open-ended aluminum or plastic tube of known volume and mass. You can use an aluminum vegetable or soup can and remove both ends. Cork borers may be used for narrow layers of snow.)
- Weather Watch Field Data sheet
- Snow Pit Field Data sheet

Procedures:

Locate and Prepare Snow Pit

1. Be careful not to walk on or alter an area you might use for the snow pit. Locate an area that is open and free from obstructions that might cause drifting. Open meadows and athletic fields make excellent locations. Choose a site representative of the snowfall in your area.
2. One group will dig the snow pit. First use your compass to determine South and make note of the position of the Sun. The wall of your snow pit must not receive direct sunlight during the measurements. Direct sunlight will cause increased temperature readings.
3. Dig a pit that is several meters wide that goes all the way to the ground level. The wall facing away from the Sun must be vertical and smooth. The pit should be large enough for several people to make measurements comfortably at the same time.
4. Anchor the measuring tape to the flat, smooth wall of the pit with golf tees or popsicle sticks. The zero point of the tape must be at ground level. Extend the tape straight up to the top snow level. Record total depth of snow.



Make Basic Weather Measurements

While the snow pit is being prepared, one group will measure and record basic weather data using Weather Watch Field Data sheet. Instructions are available on the Weather Watch From Students pages.

Map Study Site

While the snow pit is being prepared, one group will characterize the site. Draw a map of the study area. The map should represent an area at least 10m x 10m. You should Include on your map

- surface features of the snow (ripples, crust, drifts, etc.)
- any vegetative cover (trees, small bushes, etc.)
- direction of slope
- North and South
- any unusual features.

Obtain Basic Site Data

While the snow pit is being prepared, one group will complete Site Data Table on the Snow Pit Field Data sheet. This includes

- brief Site Description (where the site is)
- the Slope Aspect (use compass to determine the direction of down slope)
- Percent of Slope (use clinometer)
- Vegetative Cover (use Modified UNESCO Classification supplied by your teacher).

Measure Temperature Profile of Snowpack

1. The metric tape must be in place and anchored with zero at ground level and tape extended straight up to surface of snow.
2. Measure ground temperature to nearest 0.1°C and then the temperature immediately above the ground. This becomes the temperature at the zero height measurement. Record this temperature measurement in the *bottom* box of the Temperature Data Table. All subsequent measurement will be recorded in the next box up. This emphasizes that you are measuring from the bottom of the snowpack to the top.
3. Measure the temperature of the snow every 10cm (every 5 cm if total depth of snow is less than 0.5m) to the nearest 0.1°C and record in Temperature Data Table. (Be careful that data entries start at the bottom of the table and are entered upward.)

Mark Snow Layers

The snowpack will consist of layers representing snowfalls and other weather events. Different layers may be of soft or granular snow. Daytime thaw followed by nighttime freezing and/or freezing rain may create ice layers. Some layers may be wetter than others. Your task is to identify the layers and determine their height above the ground and their thickness.

1. *Visual Inspection:* Stand in front of the smooth, vertical wall of the snow pit, and make your first inspection by eye. Ice layers appear shiny. Large grains glisten and appear pebbly. Soft snow may appear less reflective.
2. Insert markers (golf tees, toothpicks, popsicle sticks) into the wall close to the metric tape at the top and bottom of each layer.
3. *Naked Finger Test:* To refine your visual inspection use the tip of your bare index finger and move it gently through the snow from the surface to the ground level. You may feel differences in hardness or graininess that you were unable to see. Insert additional markers at the top and bottom of any new layers you detect.
4. *Knife Test:* Refine the mapping of layers by gently slicing a knife down through the profile and noticing any changes in resistance to the knife. Revise your marker positions as needed.
5. With all of the layer markers in place near the metric tape, record the height of each layer above the ground and the thickness of each layer in the Layer Profile

Table. The ground will be the bottom of the first layer and is at zero height. Marker #1 (the first marker above the ground) will be the top of the first (bottom) layer. The distance from the ground (0.0cm) to Marker #1 is the thickness of the first layer. Marker #1 also marks the bottom of the second layer. The distance from the ground to Marker #1 is the height of the second layer. The distance from Marker # 1 to Marker #2 is the thickness of the second layer. Continue making and recoding layer measurements all the way to the surface.

Determine Layer Hardness

Snow hardness readings should be taken in the center of each distinct snow layer. Ice layers will be identified as Ice in the Layer Profile Table. Professionals use a Hardness Gauge that consists of disks of varying surface area. The technique is to slowly press each disc squarely against the snow and use a scale that records a value indicating pressure (g/cm) at which the disc begins to enter the snow. Instead of a hardness gauge you will use your hand, a pencil, and a knife to estimate hardness. This is called the Hand Test. It is detailed on snow cards and is commonly used by professionals when they don't have a Hardness Gauge.

1. Start at Layer 1 (the layer nearest the ground).
 - If the layer is ice, record this layer as Ice.
 - If the first layer is not ice, gently push your fist into the middle of the layer. If your fist penetrates the layer easily, record this layer as Very Soft.
 - If your fist *doesn't* penetrate easily, hold your hand flat and horizontal so that the tips your four fingers are just touching the snow and push gently. If your four fingers penetrate the snow easily, record the layer as Soft.
 - If your four fingers *don't* penetrate easily, push gently into the snow with the tip of one finger. If one finger penetrates the snow easily, record the layer as Medium.
 - If one finger *doesn't* penetrate easily, gently push the sharpened end of a pencil into the snow. If the pencil penetrates easily, record this layer as Hard.
 - If the pencil *doesn't* penetrate easily, gently push the tip of a knife into the snow. If the knife penetrates easily, record this layer as Very Hard.
2. Repeat this procedure on all layers.

Test	Estimated Hardness
Fist	Very Soft
Four Fingers (Tips)	Soft
One Finger (Tip)	Medium
Pencil Point	Hard
Knife	Very Hard
	Ice

Determine Snow Grain Size and Shape

1. Collect a sample of snow from the bottom layer of the snow pit by gently scraping the snow with the plastic card so that the snow is retained on the card.
2. Examine with hand lens. Select 5 average grains at random.
3. Use the grid on the card (or small metric ruler) to measure size of crystal and record on Layer Profile Table.
4. Identify the shape of the grain. For Comparative Images of Snow Crystals visit <http://emu.arsusda.gov/snowsite/comparison/comp5.html>, pages 5 and 6. The large images are from electron microscopes and the inset image is with a regular microscope.
 - If whole crystal or parts of broken crystal, record as Fresh Snow.
 - If grains are irregular and rounded, record as Granular.
 - If grains are irregular with flat surfaces, record as Faceted.
 - If grains are hollow, cup-shaped crystals, record as Depth Hoar.
5. Repeat with next layer until you have identified the dominant grains in each layer.

Measure Snow Density and Snow Water Equivalent

To measure the density of the snow and to determine the percent of water in the snow, it is necessary to obtain a known volume of snow and find the mass of the snow.

Density is defined as mass divided by volume. You will use a snow sampling tube.

This may be a plastic or aluminum tube (an aluminum vegetable can may be used).

You can only measure the density of a layer that is as thick as or thicker than the snow sampling tube.

*In the classroom measure the diameter and length of snow sampling tube and calculate the volume of the tube and record this volume. Also mass the snow sampling tube when it is clean and dry.

1. Begin at the top layer that is thick enough to sample. Clearly identify which layer you are sampling. Firmly push the snow sampling tube into the snow face of the top layer using the edges of the tube as push points. The greatest error source is an incomplete fill of the cylinder. The best way to accomplish the "fill" is to push the cylinder in beyond the face surface and then cut a channel over the tube that will enable a metal shave plate to be used to dress off the back and front faces of the cylinder. This is why you start at the top.
2. Carefully mass the snow sampling tube filled with snow in grams. Record this mass. You can calculate the density and % water content of the snow in the classroom.
3. Empty tube and repeat with next layer down and repeat until you have sampled all layers.

*Be careful when you record density and % water in the Layer Profile Table. Every other measurement has started with the bottom layer of the snow pit as the first layer. Because you are digging into the snow face, you are starting with the top layer first. Be careful to record the density with the proper layer. In addition, you may be not be able

to sample a layer because it is too narrow for the sampling tube. Be certain that you skip a layer in the Layer Profile Table if you did not sample it.

Equations and Calculations for Density and % Water Content.

Volume of cylinder (sampling tube) = $\pi r^2 L$ (this is also the volume of snow if the tube is full of snow)

$\pi = 3.14$

r = radius of tube or diameter divided by 2

L = length of tube

Mass of snow in sampling tube = (mass of tube and snow – mass of empty tube)

Density of snow = (mass of snow) ÷ (Volume of snow)

% Water Content = Density of snow x 100